California LCFS fuel pathway modification: Low-FFA used cooking oil to biodiesel in Hong Kong with electricity as the only process fuel

GREET modeling technical support document

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I. Introduction (Public)

We are applying to add a new pathway to the California LCFS fuel carbon-intensity lookup table. This pathway is a modification to a previously submitted pathway for biodiesel produced in South Korea from used cooking oil. We are starting with the South Korea UCO pathway GREET model rather than the published Midwest UCO pathway GREET model [1] to avoid repeating the addition of the biodiesel transportation by ocean tanker process to CA_GREET. However, the reference pathway in Section III, Table 1 used to demonstrate the increase in emissions is the published Midwest UCO pathway. The pathway under consideration uses mechanical separation instead of "cooking" to refine the used cooking oil.

Except for the points of deviation summarized below, our pathway is identical to the South Korea UCO pathway GREET model. The pathway differs only in the following:

1) The feedstock and fuel are both produced in Hong Kong and shipped to California via ocean tanker for distribution and consumption, and
2) Values specific to the Hong Kong facility, including the use of electricity as the only process fuel, are used in the calculation of fuel production energy use.

This application is for low-FFA or "yellow grease" UCO. Based on our modeling in CA-GREET, we find that the modified pathway has a carbon intensity of **34.82** $gCO_2e\ MJ^{-1}$.

II. Company Details (Public)

Champway Technology Ltd. is a biodiesel production facility located at EcoPark, 133 Lung Mun Rd., Tuen Mun, N.T., Hong Kong SAR. It was constructed between October 2008 and March 2010. It is owned by China Authority Company which also owns another biodiesel plant in Shanghai.

Champway Technology operates under an operating license issued by the Environmental Protection Department. This **license limits production to 31.5 million gallons of biodiesel per year or 105,000 metric tons per year** (105,000 metric tons per year X 1,000 kg per metric ton X 2.205 lbs per kg X 1 gal per 7.35 pounds biodiesel).

Champway Technology utilizes a typical transesterification process to convert triglycerides present in Used Cooking Oil (UCO) into methyl esters. Champway Technology collects UCO from restaurants in Hong Kong including Hong Kong, Kowloon, New Territories, and Islands District.

The raw UCO is separated from wastewater and solid impurities through a centrifugal process. The treated lipids are converted to crude FAMEs in reactors by esterification and trans-esterification processes. After centrifugal separation of the crude FAMEs and

the glycerol phase, the crude FAMEs is further purified from traces of free glycerol by an absorption process. The crude FAMEs will be further refined into high quality biodiesel by a distillation process. The Champway Technology plant uses electricity provided by China Light Power for process heat.

EcoEngineers conducted an on-site 3rd party engineering review of Champway Technology's Hong kong biodiesel facility on June 10, 2013, as required under 40CFR Part 80, section 1450 to register under the EPA's Renewable Fuels Standard. EcoEngineers met with Mr. Wong Yiu Kwong, Operations Director and Miss Sindy Ho, Procurement and Public Relations Officer. The on-site review included a review of information provided by the facility prior to the visit and a tour of the quality control laboratory and renewable fuel production facility.

III. Table of changes to baseline CA-GREET model inputs for the Champway Pathway (Public)

Table 1: Changes from CA_GREET spreadsheet for South Korean UCO biodiesel pathway to Hong Kong UCO biodiesel pathway

Parameter	Cell location	S. Korea UCO value	Hong Kong UCO value	Units	Explanation
Res. oil electric generation	Regional LT!J83	4.40%	0%	%	Electric generation mix for Hong Kong [3]
Natural gas electric generation	Regional LT!J84	49.5%	23%	%	Electric generation mix for Hong Kong [3]
Coal electric generation	Regional LT!J85	46.0%	54%	%	Electric generation mix for Hong Kong [3]
Nuclear electric generation	Regional LT!J86	0.0%	23%	%	Electric generation mix for Hong Kong [3]
Biomass electric generation	Regional LT!J87	0.1%	0%	%	Electric generation mix for Hong Kong [3]
Other (renewables) electric generation	Regional LT!J88	0.0%	0%	%	Electric generation mix for Hong Kong [3]
UCO processing NG use	UCO BD!C189	125	0	btu/lb UCO	Champway uses only electricity for process heat
UCO processing electricity use	UCO BD!C192	27	226	btu/lb UCO	Champway uses only electricity for process heat
FFA transesterification NG use	UCO BD!E189	155	0	btu/lb BD	Champway uses only electricity for process heat
FFA transesterification electricity use	UCO BD!E192	16	425	btu/lb BD	Champway uses only electricity for process heat
UCO transesterification	UCO BD!F189	889	0	btu/lb BD	Champway uses only electricity for process heat

NG use					
UCO transesterification electricity use	UCO BD!F192	47	1249	btu/lb BD	Champway uses only electricity for process heat
UCO transesterification methanol use	UCO BD!F194	865	1164	btu/lb BD	Higher methanol use due to lower quality feedstock
Ocean tanker transport distance	T&D!GB93	6594	7312	miles	Port to port distance from Hong Kong to Los Angeles [5]
Biodiesel truck transport distance	T&D!GC93	77	57	miles	The distance from the Hong Kong plant to the Hong Kong port is 17 miles. Forty miles are added to account for fact that 80% of fuel travels 50 miles to the bulk terminal before going to the port.

IV. Basis for the Input Values (Public)

This pathway is similar to the previously submitted CA GREET model for UCO biodiesel from South Korea, with changes in the following areas as further detailed below:

1. electricity generation mix
2. fuel production energy use
3. transport distances

The modified CA-GREET spreadsheet is included in the application packet; results can be found in the "UCO Results" tabs.

Champway Technologies' biodiesel plant only uses electricity from the grid for its process heat requirements. Monthly electricity consumption at the plant is provided in Section XII of this application. Hong Kong's electric generation mix is 54% coal, 23% natural gas, and 23% nuclear power [3]. Because there are several new nuclear power plants scheduled to be built to service Hong Kong and Guandong Province [4] and therefore nuclear power cannot be excluded from the marginal mix, we assume that marginal increase in demand will be met with the same mix in electric generation as the current average mix.

Champway Technologies' utility bills for 2012 reflect a high and low level of energy consumption each month. This is because Champway has also used high-FFA "brown grease" UCO in the past as feedstock for biodiesel production. In 2012, the feedstock mix for biodiesel production at Champway was approximately 40% yellow grease and 60% brown grease. The raw brown grease processed contained 10 - 30% of oil, and heating and centrifugal separation was applied to purify the oil. Therefore, the energy consumption was higher when the plant processed the brown grease. The methanol input

is also greater to process the brown grease for biodiesel production. We have separately modeled high FFA brown grease and found that the high FFA brown grease biodiesel pathway has a carbon intensity of 42.65 $gCO_2e\ MJ^{-1}$.

In 2013 and for sales to California, Champway intends to only use low-FFA yellow grease for biodiesel production. Energy use used to model the submitted pathway is based on facility data for year 2013 when low-FFA UCO feedstock was used. This application is only for a new pathway for a low-FFA yellow grease biodiesel at Champway, which has a carbon intensity of **34.82 $gCO_2e\ MJ^{-1}$**.

V. CA-GREET Model Output (Public)

Table 2: Energy use and emissions from UCO biodiesel produced in the Midwestern U.S. and in Hong Kong, separated by life cycle stage. Figures are rounded.

	UCOME Cooking Not Required, Fuel produced in the Midwest		**UCOME Cooking Not Required, Fuel produced in Hong Kong**			
	Energy (BTU/MMBTU BD)	**Emissions (gCO2e/MJ)**	**Energy (BTU/MMBTU BD)**	**Emissions (gCO2e/MJ)**	**% difference**	
UCO Transport to Rendering Plant	0.00	0.00	0.00	0.00	0	0
Rendering of UCO		0.80	38252	3.26		307%
UCO Transport (after rendering)	3912	0.30	0.00	0.00	100%	100%
Biodiesel Production	174956	6.06	380521	23.44	117%	287%
Biodiesel Transport	28384	2.19	44682	3.65	57%	67%
Total (Well To Tank)		**9.35**	**463456**	**30.34**		**225%**
Total (Tank To Wheel)	**1000000**	**4.48**	**1000000**	**4.48**	**0**	**0**
Total (Well To Wheel)		**13.83**	**1463456**	**34.82**		**152%**

* Empty cells indicate values that could not be found in references [1] or [2].

VI. Discussion of Results (Public)

Table 2 compares energy use and emissions from the proposed pathway to those from reference [2] for UCO biodiesel produced in the Midwestern U.S. without cooking. Emissions from UCO rendering are higher for production in Hong Kong compared to production in the Midwestern U.S. owing to "dirtier" electrical production in China compared to the Midwestern U.S. and increased energy use at the fuel production facility. Energy use is based on facility data for year-2013 when low-FFA UCO feedstock was used. Because the UCO rendering and biodiesel facilities in Hong Kong are co-located,

the Hong Kong biodiesel does not include emissions from transportation between the facilities. Shipping the UCO from China by ocean tanker creates more emissions than shipping UCO from the Midwest by rail.

VII. Production Range of Champway Technologies Pathway (Public)

The new pathway should be applicable to the Champway facility in Hong Kong for 100% (31,500,000 gallons/year) of Permitted Capacity.

VIII. Sustainability of Champway Pathway (Public)

The Champway facility was designed and constructed using well-established modern designs and equipment and is managed by professional staff well-qualified to assure that over time the energy efficiency of and emissions from the facility do not deteriorate. Any deterioration would result in a less profitable business. Thus the sustainability of the plant is well aligned with the business objectives of the owners.

IX. Impact on Land Use (Public)

Since the raw material discussed is Used Cooking Oil, there is no land use impact.

X. Conclusion (Public)

Based on our modeling in CA-GREET and the available data, we find that biodiesel produced from low-FFA or "yellow grease" UCO at Champway Technlogies has a carbon intensity of **34.82** $gCO_2e\ MJ^{-1}$.

XI. References (Public)

1. *Detailed California-Modified GREET Pathway for Biodiesel Produced in the Midwest from Used Cooking Oil and Used in California*. Version 2.0. California Environmental Protection Agency Air Resources Board, 2011.

2. *Detailed California-Modified GREET Pathway for Biodiesel Produced in California from Used Cooking Oil*. Version 2.0. California Environmental Protection Agency Air Resources Board, 2009.

3. Electrical and Mechanical Services Department, HKSARG, "Energyland – The energy scene of Hong Kong", http://www.energyland.emsd.gov.hk/en/energy/energy_use/energy_scene.html (Accessed August 14, 2013).

4. Wikipedia, "大亚湾核电站", https://zh.wikipedia.org/wiki/%E5%A4%A7%E4%BA%9A%E6%B9%BE%E6%A0%B8%E7%94%B5%E7%AB%99 (Accessed August 14, 2013).

5. Farnel Capital Incorporated. *Port to port distances*, 2013. Available from: http://www.searates.com/reference/portdistance/ (Accessed August 14, 2013).

XII. Documents supporting Annual Quantities of electricity use and biodiesel production (Private)